

Student Name:

Student id:

Section #: A Serial:

University of Bahrain
Department of Computer Science

College of Information Technology
ITCS332: Concepts of Programming Languages

QUIZ#2: Chapter 3_Syntax

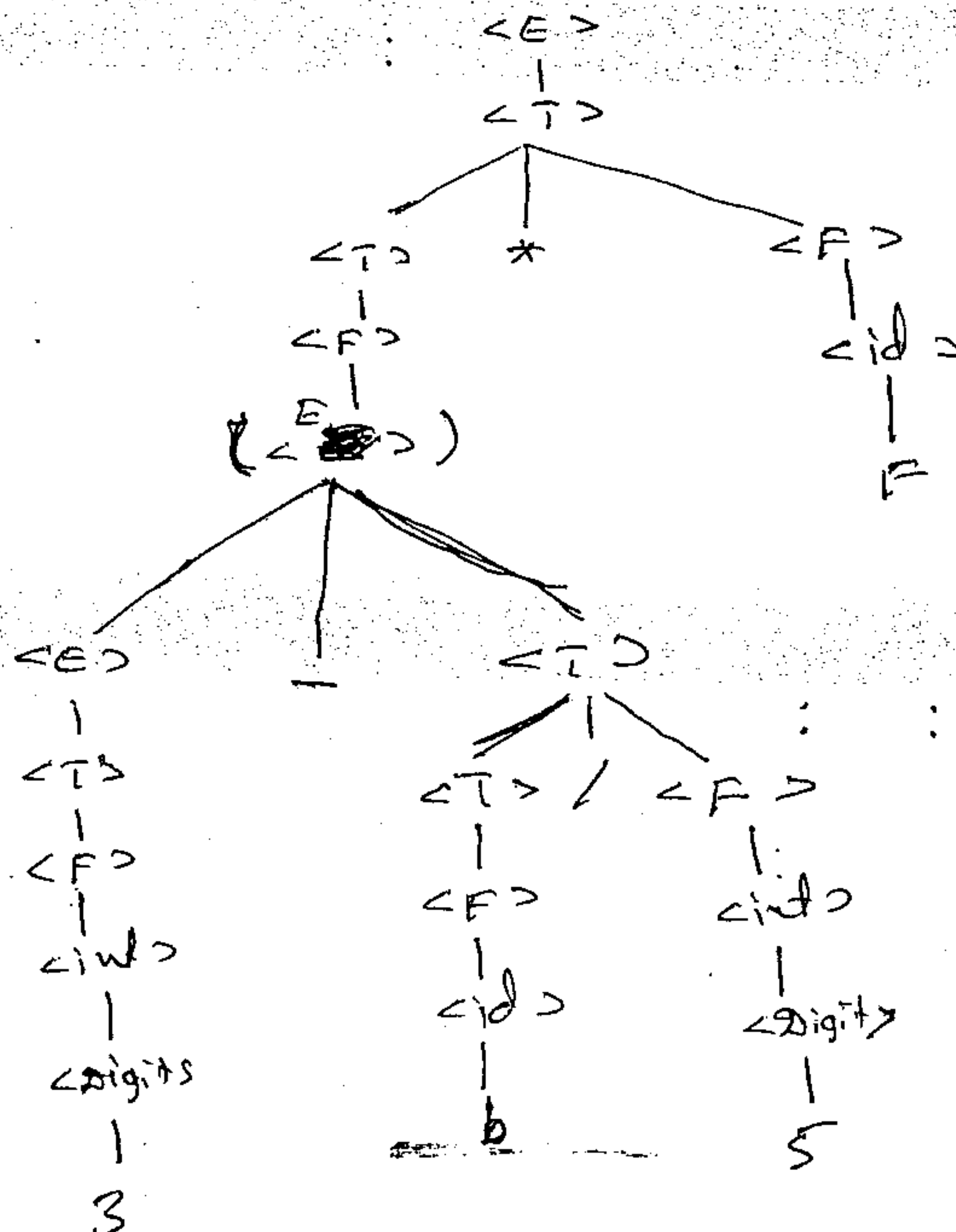
Study carefully the following grammar and answer the next three questions:

- 7) $\langle E \rangle \rightarrow \langle T \rangle \mid \langle E \rangle + \langle T \rangle \mid \langle E \rangle - \langle T \rangle \quad \langle E \rangle \rightarrow \langle T \rangle \{ (+|-) \langle T \rangle \}$
→ 8) $\langle T \rangle \rightarrow \langle F \rangle \mid \langle T \rangle * \langle F \rangle \mid \langle T \rangle / \langle F \rangle \quad \langle T \rangle \rightarrow \langle F \rangle \{ (*|/) \langle F \rangle \}$
9) $\langle F \rangle \rightarrow \langle \text{int} \rangle \mid \langle \text{id} \rangle \mid (\langle E \rangle) \quad \langle \text{int} \rangle \rightarrow \langle D \rangle \{ \langle D \rangle \}$
→ 10) $\langle \text{int} \rangle \rightarrow \langle D \rangle \mid \langle \text{int} \rangle \langle D \rangle$
11) $\langle \text{id} \rangle \rightarrow (A|B|C|D|E|F|a|b|c|d|e|f) [\langle \text{Digit} \rangle]$
12) $\langle \text{Digit} \rangle \rightarrow 0|1|2|3|4|5|6|7$

- ① 4) The max number of characters allowed in the definition of the $\langle \text{id} \rangle$ in rule #11 is 2
5) Convert each rule with left recursion into an equivalent EBNF rule.

- ⑦ $\langle E \rangle \rightarrow \langle T \rangle \{ (+|-) \langle T \rangle \}$
⑧ $\langle T \rangle \rightarrow \langle F \rangle \{ (*|/) \langle F \rangle \}$
⑩ $\langle \text{int} \rangle \rightarrow \langle D \rangle \{ \langle D \rangle \}$

- 6) Draw the parse tree for the string " $(3 - b / 5) * F$ ".



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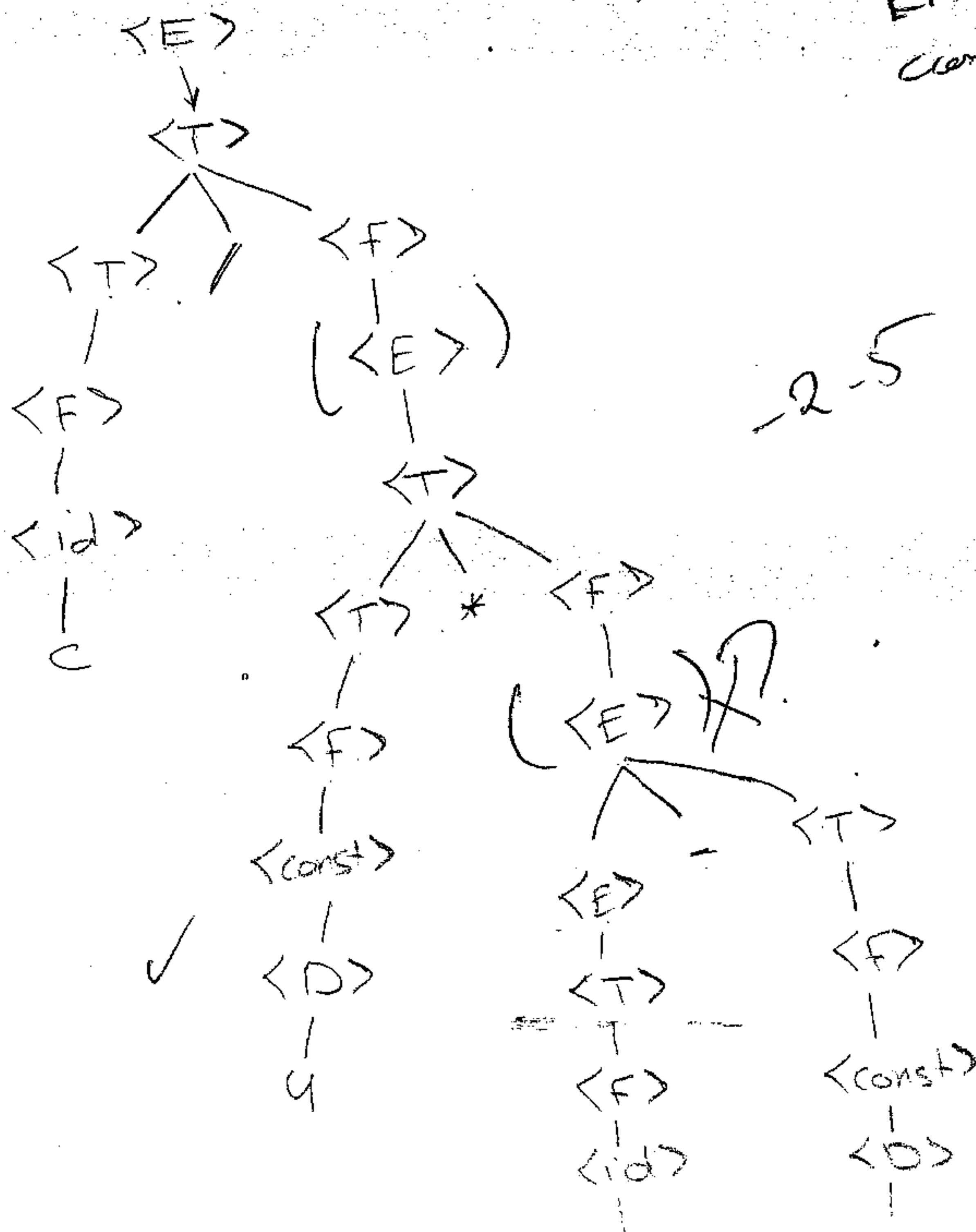
Study carefully the following grammar and answer the next three questions:

- 1) $\langle E \rangle \rightarrow \langle T \rangle \{ (+|-) \langle T \rangle \}^*$
- 2) $\langle T \rangle \rightarrow \langle F \rangle \{ (/|*|) \langle F \rangle \}^*$
- 3) $\langle F \rangle \rightarrow \langle \text{const} \rangle | \langle \text{id} \rangle | (\langle E \rangle)$
- 4) $\langle \text{const} \rangle \rightarrow \langle D \rangle \{ \langle D \rangle \}^*$
- 5) $\langle \text{id} \rangle \rightarrow \langle A | B | C | D | E | F \rangle [\langle D \rangle]$
- 6) $\langle D \rangle \rightarrow 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9$

- 1) The max number of characters allowed in the definition of the $\langle \text{id} \rangle$ in rule #5 is one character only (1)
- 2) Convert each rule with left recursion into an equivalent EBNF rule.

- ① $\langle E \rangle \rightarrow \langle T \rangle \{ (-|+) \langle T \rangle \}^*$
- ② $\langle T \rangle \rightarrow \langle F \rangle \{ (/|*) \langle F \rangle \}^*$
- ③ $\langle \text{const} \rangle \rightarrow \langle D \rangle \{ \langle D \rangle \}^*$

- 3) Draw the parse tree for the string "C / (4 * A - 7)".



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QUIZ#2: Chapter 3_Syntax

QUESTION 1: Assume

$\langle \text{digit} \rangle ::= 0|1|2|3|4|5|6|7$

Give EBNF rules to define a constant consisting of any number of digits (0, 1, 2, ...7) followed by ONE of the following symbols: #, %, \$, &

Sample constants: 23#, 5623\$, 101&

$\langle \text{digits} \rangle \rightarrow \{ \langle \text{digit} \rangle \} (\#|\%|\$|\&)$

$\langle \text{digit} \rangle \rightarrow 0|1|2|3|4|5|6|7$

QUESTION 2: Study carefully the following grammar and:

- 7) $\langle E \rangle \rightarrow \langle T \rangle | \langle E \rangle + \langle T \rangle | \langle E \rangle - \langle T \rangle$
- 8) $\langle T \rangle \rightarrow \langle F \rangle | \langle F \rangle * \langle T \rangle | \langle F \rangle / \langle T \rangle$
- 9) $\langle F \rangle \rightarrow \langle \text{int} \rangle | \langle \text{id} \rangle | (\langle E \rangle)$
- 10) $\langle \text{int} \rangle \rightarrow \langle D \rangle | \langle \text{int} \rangle \langle D \rangle$
- 11) $\langle \text{id} \rangle \rightarrow (\#|\&|?!|\$) [\langle D \rangle]^*$
- 12) $\langle D \rangle \rightarrow 0|1|2|3|4|5|6|7$

- The minimum number of $\langle F \rangle$ in $\langle T \rangle$ is : one $\langle T \rangle$ and one $\langle F \rangle$
- The maximum number of characters in the $\langle \text{int} \rangle$ is : 2
- Write down the right-most derivations for the string "51 / (\$2 - ?7)".

$\langle E \rangle \rightarrow \langle T \rangle$
 $\rightarrow \langle F \rangle / \langle T \rangle$
 $\rightarrow \langle F \rangle / \langle F \rangle$
 $\rightarrow \langle \text{int} \rangle / \langle F \rangle$
 $\rightarrow \langle \text{int} \rangle \langle E \rangle$
 $\rightarrow \langle \text{int} \rangle \langle D \rangle / \langle E \rangle$
 $\rightarrow \langle \text{int} \rangle \langle D \rangle / (\langle E \rangle - \langle T \rangle)$
 $\rightarrow \langle \text{int} \rangle 1 / (\langle E \rangle - \langle T \rangle)$
 $\rightarrow \langle D \rangle 1 / (\langle E \rangle - \langle T \rangle)$
 $\rightarrow \langle D \rangle 1 / (\langle E \rangle - \langle F \rangle)$
 $\rightarrow \langle D \rangle 1 / (\langle T \rangle - \langle F \rangle)$
 $\rightarrow 51 / (\langle T \rangle - \langle F \rangle)$
 $\rightarrow 51 / (\langle T \rangle - \langle \text{id} \rangle)$
 $\rightarrow 51 / (\langle F \rangle - \langle \text{id} \rangle)$

$\rightarrow 51 / (\langle F \rangle - ? \langle D \rangle)$
 $\rightarrow 51 / (\langle \text{id} \rangle - ? \langle D \rangle)$
 $\rightarrow 51 / (\langle \text{id} \rangle - ? 7)$
 $\rightarrow 51 / (\$ \langle D \rangle - ? 7)$
 $\rightarrow 51 / (\$2 - ? 7)$

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QUIZ#2: Chapter 3_Syntax

QUESTION 1: Assume

$\langle \text{digit} \rangle ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7$

Give EBNF rules to define a constant consisting of any number of digits (0, 1, 2, ..., 7) followed by ONE of the following symbols: #, %, \$, &

Sample constants: 23#, 5623\$, 101&

$\langle \text{digits} \rangle \rightarrow \{ \langle \text{digit} \rangle \}^* (\% | \$ | \&)$

$\langle \text{digit} \rangle \rightarrow 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7$

$\langle \text{digits} \rangle \rightarrow \{ \langle \text{digit} \rangle \} (\# | \% | \$ | \&)$

$\langle \text{digit} \rangle \rightarrow 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9$

QUESTION 2: Study carefully the following grammar and:

7) $\langle E \rangle \rightarrow \langle T \rangle \mid \langle E \rangle + \langle T \rangle \mid \langle E \rangle - \langle T \rangle$

8) $\langle T \rangle \rightarrow \langle F \rangle \mid \langle F \rangle * \langle T \rangle \mid \langle F \rangle / \langle T \rangle$

9) $\langle F \rangle \rightarrow \langle \text{int} \rangle \mid \langle \text{id} \rangle \mid (\langle E \rangle)$

10) $\langle \text{int} \rangle \rightarrow \langle D \rangle \mid \langle \text{int} \rangle \langle D \rangle$

11) $\langle \text{id} \rangle \rightarrow (\# | \% | ? | ! | \$) [\langle D \rangle]$

12) $\langle D \rangle \rightarrow 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7$

- The maximum number of $\langle F \rangle$ in $\langle T \rangle$ is: in numbers because it is recursion rule
- The maximum number of characters in the $\langle \text{int} \rangle$ is: in numbers because it's recursion rule.
- Write down the right-most derivations for the string "51 / (\$2 - ?7)".

$\langle E \rangle \Rightarrow \langle T \rangle$

$\Rightarrow \langle F \rangle / \langle T \rangle$

$\Rightarrow \langle F \rangle / \langle F \rangle$

$\Rightarrow \langle F \rangle / (\langle E \rangle)$

$\Rightarrow \langle F \rangle / (\langle E \rangle - \langle T \rangle)$

$\Rightarrow \langle F \rangle / (\langle E \rangle - \langle F \rangle)$

$\Rightarrow \langle F \rangle / (\langle E \rangle - \langle \text{id} \rangle)$

$\Rightarrow \langle F \rangle / (\langle E \rangle - ? \langle D \rangle)$

$\Rightarrow \langle F \rangle / (\langle E \rangle - ?7)$

$\Rightarrow \langle F \rangle / (\langle T \rangle - ?7)$

$\Rightarrow \langle F \rangle / (\langle F \rangle - ?7)$

$\Rightarrow \langle F \rangle / (\langle \text{id} \rangle - ?7)$

$\Rightarrow \langle F \rangle / (\$ \langle D \rangle - ?7)$

$\Rightarrow \langle F \rangle / (\$2 - ?7)$

$\Rightarrow \langle \text{int} \rangle / (\$2 - ?7)$

$\Rightarrow \langle \text{int} \rangle \langle D \rangle / (\$2 - ?7)$

$\Rightarrow \langle \text{int} \rangle / (\$2 - ?7)$
 $\Rightarrow \langle D \rangle / (\$2 - ?7)$
 $\Rightarrow 51 / (\$2 - ?7)$

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QUIZ#2: Chapter 3 Syntax

QUESTION 1: Give BNF rules to define sentences consisting of # symbol preceded by zero or one digit and followed by zero or more letters. Sample sentences: #, 9#, #A, #AB, 3#abc. Assume

<letter> ::= A|B| ... Z|a|b|...z

<digit> ::= 0|1|2|3|4|5|6|7|8|9 are already defined.

<QUEST1> → # | <digit> # | # <Letters>

| <digit> # <Letters>

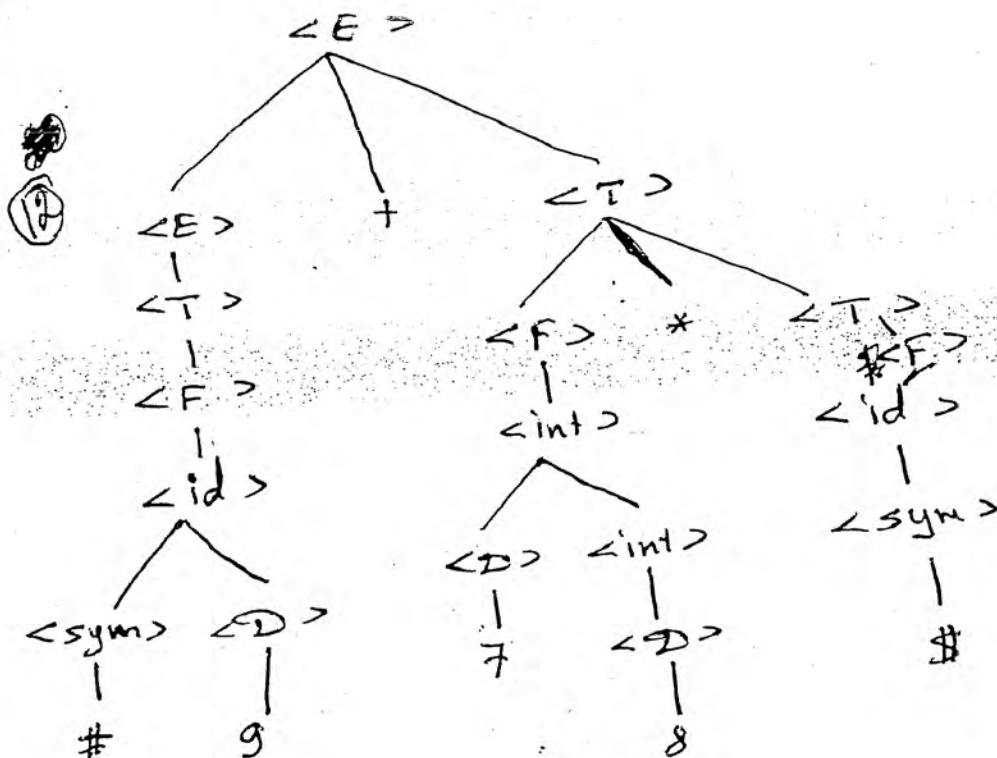
<Letters> → <Letter> | <Letter> <Letters>

QUESTION 2: Study carefully the following grammar and:

- 1) <E> → <T> | <E> + <T> | <E> - <T>
- 2) <T> → <F> | <F> * <T> | <F> / <T>
- 3) <F> → <int> | <id> | (<E>)
- 4) <int> → <D> | <D> <int>
- 5) <id> → <sym> [<D>]
- 6) <sym> → @ | # | & | ? | ! | \$
- 7) <D> → 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9

②

- List the number(s) of right-recursive rules: 2, 4
- Draw the parse tree for the string "#9 + 78 * \$".



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QUIZ#2: Chapter 3 - Syntax

QUESTION 1: Give EBNF rules to define sentences consisting of @ symbol preceded by zero or one digit and followed by zero or more letters. Sample sentences: @, 9@, @A, @AB, 3@abc. ... Assume
<letter> ::= A|B|...Z|a|b|...z
<digit> ::= 0|1|2|3|4|5|6|7|8|9 are already defined.

⑥ $\langle \text{QUEST} \rangle \rightarrow [\langle \text{digit} \rangle] @ \{ \langle \text{letter} \rangle \}$

QUESTION 2: Study carefully the following grammar and:

- | | |
|---------------------------------|---|
| 1) $\langle E \rangle$ | $\rightarrow \langle T \rangle \mid \langle E \rangle + \langle T \rangle \mid \langle E \rangle - \langle T \rangle$ |
| 2) $\langle T \rangle$ | $\rightarrow \langle F \rangle \mid \langle F \rangle * \langle T \rangle \mid \langle F \rangle / \langle T \rangle$ |
| 3) $\langle F \rangle$ | $\rightarrow \langle \text{int} \rangle \mid \langle \text{id} \rangle \mid (\langle E \rangle)$ |
| 4) $\langle \text{int} \rangle$ | $\rightarrow \langle D \rangle \mid \langle D \rangle \langle \text{int} \rangle$ |
| 5) $\langle \text{id} \rangle$ | $\rightarrow \langle \text{sym} \rangle [\langle D \rangle]$ |
| 6) $\langle \text{sym} \rangle$ | $\rightarrow @ \# \% ? ! \$$ |
| 7) $\langle D \rangle$ | $\rightarrow 0 1 2 3 4 5 6 7 8 9$ |

- ①
- List the number(s) of left-recursive rules: 1
 - Give the left-most derivations for the string "24 / @6 - ?5".

①8

$$\begin{aligned} \langle E \rangle &\Rightarrow \langle E \rangle - \langle T \rangle \\ &\Rightarrow \langle T \rangle - \langle T \rangle \\ &\Rightarrow \langle F \rangle / \langle T \rangle - \langle T \rangle \\ &\Rightarrow \langle \text{int} \rangle / \langle T \rangle - \langle T \rangle \\ &\Rightarrow \langle D \rangle \langle \text{int} \rangle / \langle T \rangle - \langle T \rangle \\ &\Rightarrow 2 \langle \text{int} \rangle / \langle T \rangle - \langle T \rangle \\ &\Rightarrow 2 \langle D \rangle / \langle T \rangle - \langle T \rangle \\ &\Rightarrow 2 \ 4 \ / \ \langle T \rangle - \langle T \rangle \\ &\Rightarrow 2 \ 4 \ / \ \langle F \rangle - \langle T \rangle \\ &\Rightarrow 24 / \langle \text{id} \rangle - \langle T \rangle \\ &\Rightarrow 24 / \langle \text{sym} \rangle \langle D \rangle - \langle T \rangle \\ &\Rightarrow 24 / @ \langle D \rangle - \langle T \rangle \\ &\Rightarrow 24 / @6 - \langle T \rangle \\ &\Rightarrow 24 / @6 - \langle F \rangle \\ &\Rightarrow 24 / @6 - \langle \text{id} \rangle \\ &\Rightarrow 24 / @6 - \langle \text{sym} \rangle \langle D \rangle \\ &\Rightarrow 24 / @6 - ? \langle D \rangle \\ &\Rightarrow 24 / @6 - ?5 \end{aligned}$$